

**QUARTERLY PROGRESS REPORT
MONTANA DOT "PERFORMANCE PREDICTION MODELS"**

To:	Jon Watson, MDT Susan Sillick, MDT
Agency:	Fugro-BRE, Inc.
MDT Contract No.:	HWY-30604-DT
Performance Period:	March 2003
Prepared By:	Brian Killingsworth, PE, Principal Investigator
Date Prepared:	May 12, 2003

1.0 CURRENT MONTH WORK ACTIVITIES AND ACCOMPLISHMENTS

Task 1 – Literature Review

Complete. A draft memorandum summarizing the models to be considered within this project was submitted to the Department in October 2001. This memorandum will be updated when the calibration and validation of the 2002 Design Guide distress prediction models is made available.

Task 2 – Review of MT DOT Pavement-Related Data

Complete. However, Fugro-BRE will continue to monitor the LTPP database and update any missing data on the test sections with time.

Task 3 – Establish the Experimental Factorials

Complete.

Task 4 – Develop Work Plan for Monitoring and Testing

Complete. The long-term monitoring plan will be revised after the initial analyses of the data are complete under Tasks 6 and 7.

Task 5 – Presentation of Work Plan to MDT

Complete.

Task 6 – Implement Work Plan – Data Collection

On-going activities. All testing has been completed with the exception of a few of the CTB samples.

Unbound Bases and Subgrades (Subcontractor – Fugro, Houston, TX): The objective for testing the unbound materials is to obtain repeated load resilient modulus (M_R) for each unbound base and subgrade material that was sampled. Testing was completed at the optimum moisture content; therefore, the moisture-density relationship for each unbound material was determined prior to M_R testing. Once the optimum moisture content was determined, sample preparation for the M_R testing was completed. Each sample was tested in accordance with the LTPP protocol and the results recorded.

The data was fit using the "universal" resilient modulus model that is being incorporated into the AASHTO 2002 Pavement Design Guide. The regression analysis details are discussed here to

indicate the procedure that was utilized to determine the appropriate resilient modulus coefficients for the unbound bases and subgrades.

The results of the resilient modulus laboratory test consist of M_R values measured at different states of stress (combinations of deviator stress and confining pressure). Results for the Condon Base are illustrated in Figure 6.1.

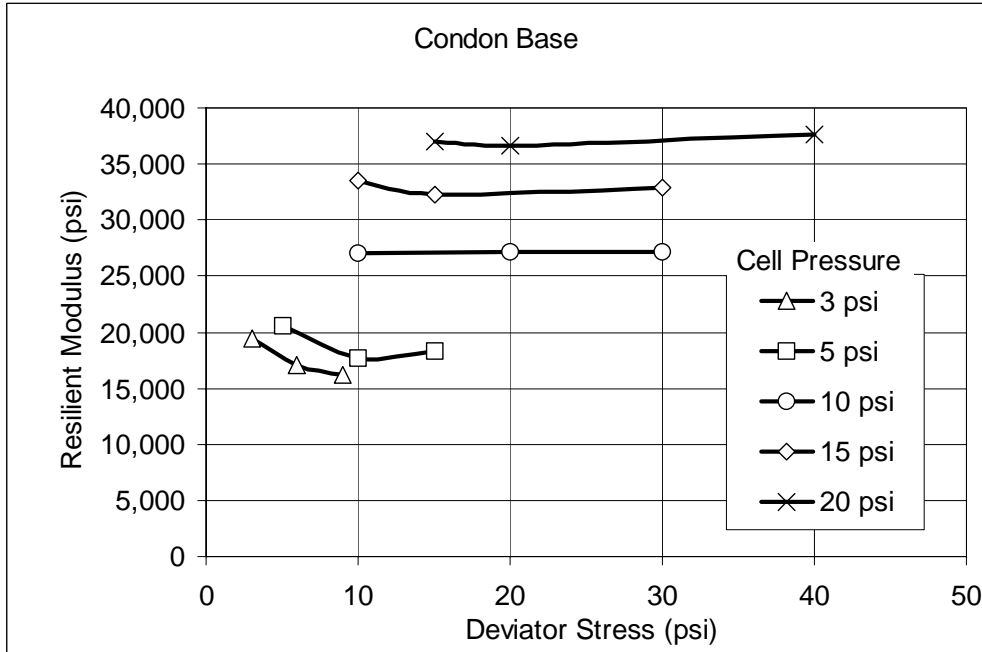


Figure 6.1 Resilient modulus test results for Condon Base.

For the Condon Base, depending on the deviator stress and confining pressure applied, the modulus ranges from 15,000 psi at the lowest confining pressure to 37,000 psi at the highest confining pressure (20 psi).

As illustrated in Figure 6.1, resilient modulus is a function of stress and a predictive equation is needed to estimate modulus values at states of stress other than those applied during the laboratory test.

The model recommended by the 2002 Design Guide for stress-dependent resilient modulus is given in Equation 6.1:

$$M_R = k_1 \cdot p_a \cdot \left(\frac{\theta}{p_a} \right)^{k_2} \cdot \left(\frac{\tau_{oct}}{p_a} + 1 \right)^{k_3} \quad (6.1)$$

Where: p_a = atmospheric pressure, in units consistent with the units used for θ and τ_{oct}
 k_1, k_2, k_3 = regression constants
 θ = bulk stress:

$$\theta = \sigma_1 + \sigma_2 + \sigma_3 \quad (6.2)$$

τ_{oct} = octahedral shear stress:

$$\tau_{oct} = \frac{1}{3} \cdot \sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2} \quad (6.3)$$

$\sigma_1, \sigma_2, \sigma_3$ = major, intermediate and minor principal stresses

The algorithm used to obtain the values of the k_1 , k_2 and k_3 regression constants is listed as:

1. Arrange laboratory test data on three columns as follows: Deviator stress (psi), Confining Pressure (psi) and Resilient Modulus (M_R) (psi).
2. Calculate in the next three columns: Bulk Stress (Equation 2), Octahedral Shear Stress (Equation 3), and $\log(M_R)$.
3. Insert initial (guess) values for the regression constants k_1 (use 1,000), k_2 (use 0.5) and k_3 (use -0.5).
4. Calculate in a 7th column the predicted resilient modulus, using Equation 1.
5. Calculate in a 8th column the squared errors: $(\log(\text{column 7}) - \log(M_R))^2$
6. Calculate the sum of all terms in column 8 (SES = sum of errors squared)
7. Calculate the standard deviation of terms in column $\log(M_R)$ and label S_y
8. Calculate the standard error of estimate Se as $(SES/(n-3))^{0.5}$ where n is the number of data points
9. Calculate in a separate cell the ratio Se/S_y
10. Calculate R^2 as $1 - (Se/S_y)^2$
11. In Excel, use Solver (from the Tools menu) to "minimize" Se/S_y "by changing cells" k_1 , k_2 and k_3
12. End

A plot of predicted vs. measured M_R can be used to illustrate the accuracy of the predictive model.

An example Excel spreadsheet that was developed using instructions 1 to 12 above is given in Figure 6.2.

The results of fitting the data are shown in Table 6.1.

The resilient modulus at a typical state of stress for a base and subgrade are shown in Figures 6.3 and 6.4.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6			Column 7	Column 8
Deviator Stress (psi)	Confining Pressure (psi)	Resilient Modulus (psi)	θ (psi)	τ_{oct} (psi)	$\log(M_R)$ (psi)			Predicted M_R (psi)	Error ²
2.73	3.00	19,383	11.73	1.29	4.287	k1	1,235	15,383	0.010076
5.49	3.00	17,070	14.49	2.59	4.232	k2	0.548	16,612	0.000140
9.00	3.00	16,202	18.00	4.24	4.210	k3	-0.497	17,880	0.001832
4.47	5.00	20,557	19.47	2.11	4.313			19,811	0.000258
7.41	5.00	17,662	22.41	3.50	4.247	SES	0.023	20,573	0.004389
10.62	5.00	18,325	25.62	5.01	4.263	Sy	0.135	21,276	0.004205
9.14	10.00	27,014	39.14	4.31	4.432			27,326	0.000025
18.41	10.00	27,130	48.41	8.68	4.433	n	15	27,704	0.000083
27.83	10.00	27,156	57.83	13.12	4.434	Se	0.044	28,013	0.000182
9.11	15.00	33,525	54.11	4.29	4.525			32,647	0.000133
13.81	15.00	32,281	58.81	6.51	4.509	Se/Sy	0.32	32,350	0.000001
27.93	15.00	32,864	72.93	13.16	4.517	R ²	0.90	31,785	0.000210
13.87	20.00	37,024	73.87	6.54	4.568			36,632	0.000021
18.43	20.00	36,637	78.43	8.69	4.564			36,085	0.000043
37.16	20.00	37,682	97.16	17.52	4.576			34,612	0.001362

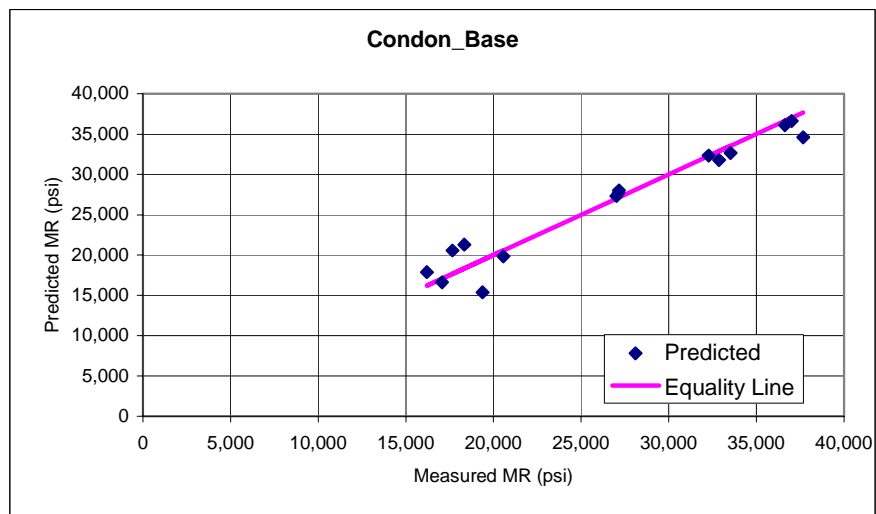


Figure 6.2 Example Excel spreadsheet for resilient modulus regression.

Table 6.1 Summary of Model Coefficients for Resilient Modulus of Unbound Soils

Material	n	k ₁	k ₂	k ₃	R ²
Condon_Base	15	1,235	0.548	-0.497	0.90
Condon_Subgrade	15	1,568	1.007	-1.689	0.97
Deerlodge_Base	15	995	0.655	-0.533	0.89
Derlodge_Subgrade	15	1,134	0.346	0.128	0.81
Ft Belknap_Base	15	928	0.671	-0.326	0.99
Ft Belknap_Subgrade	15	632	0.450	0.926	0.94
Ft Belknap_Mix	15	1,776	0.563	-0.796	0.93
Geyser_Base	15	1,172	0.599	-0.474	0.96
Geyser_Subgrade	15	1,911	0.433	-0.317	0.96
Hammond_Base	15	896	0.586	-0.204	0.98
Hammond_Subgrade	13	2,669	0.764	-3.796	0.84
Lavina_Subgrade	14	1,825	1.130	-2.659	0.94
Perma_Base	15	803	0.565	-0.871	0.88
Perma_Subgrade	15	1,435	0.555	-2.539	0.94
Roundup_Subgrade	15	1,350	0.455	-1.160	0.93
Silver City_Base	15	1,091	0.648	-0.363	0.99
Silver City_Subgrade	15	1,548	0.491	-2.087	0.96
Wolf Pt_Subgrade	12	1,765	0.332	-1.000	0.71

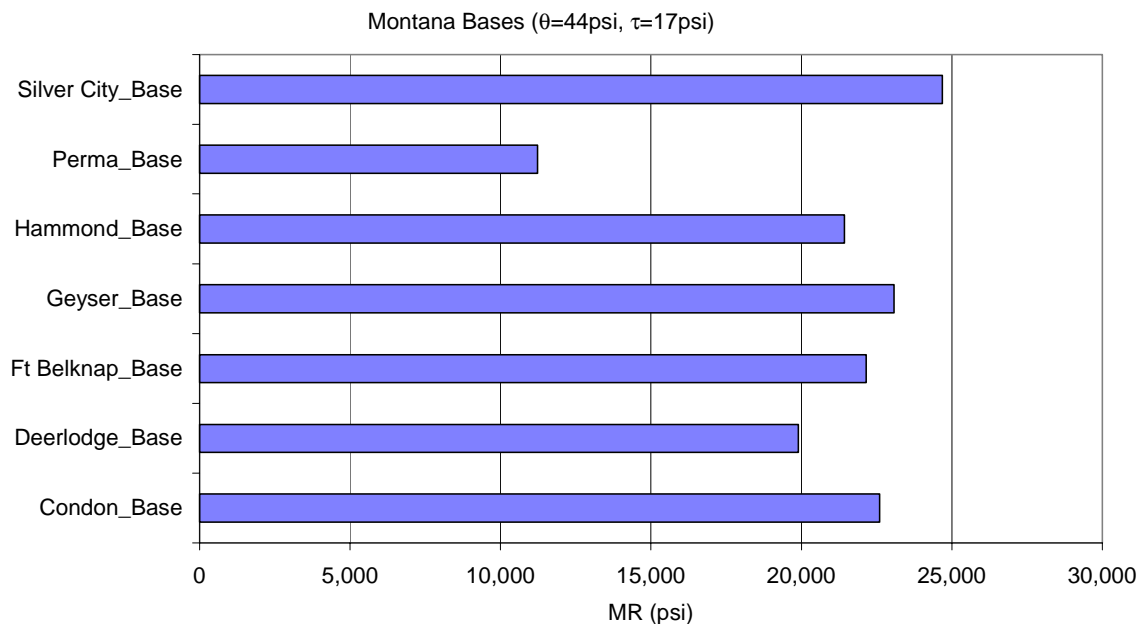


Figure 6.3 Summary of resilient modulus values using typical stress states for base materials.

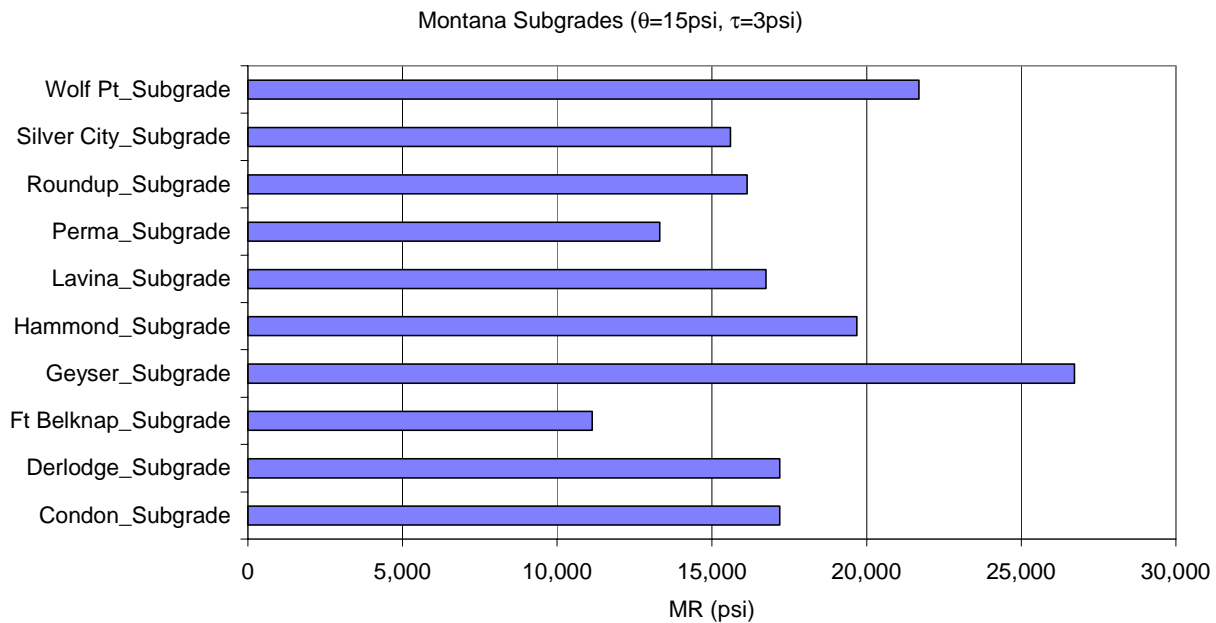


Figure 6.4 Summary of resilient modulus values using typical stress states for subgrade materials.

An important observation from these results is that the resilient modulus for the base was only slightly greater than for the subgrade soils for most of the sites with a granular base layer.

HMA Cores (Subcontractor – Advanced Asphalt Technologies, Sterling, VA): All testing has been completed. There were two objectives for testing the HMA cores. The first was to obtain data for the Superpave Thermal Fracture analysis. This required low temperature creep and strength data at three temperatures. The second objective was to obtain resilient modulus data to verify stiffness values obtained from the Witczak dynamic modulus equation.

In summary, for each section, three cores were tested for M_R at three temperatures, and IDT strength with strain to failure were obtained at the same temperatures as the M_R tests using 2 specimens per temperature. The same was true for low temperature testing as well. Three cores were tested for creep compliance, and IDT strength was obtained at the same temperatures as the compliance tests using 2 specimens.

The Tables 6.2 and 6.3 summarize the testing completed on the HMA cores.

**Table 6.2 Summary of Laboratory Determined Resilient Modulus
for Asphalt Concrete Materials**

Site	Statistics	Air Voids	Total Resilient Modulus, psi		
			4C	16C	27C
SILVER CITY	Average, psi	3.1	1,896,057	667,058	292,107
	Std. Dev., psi	1.2	445,047	123,166	76,620
	COV, %	39.5	23.5	18.5	26.2
BECKHILL	Average, psi	5.1	1,287,069	495,043	191,744
	Std. Dev., psi	0.6	100,379	60,173	30,456
	COV, %	12.4	7.8	12.2	15.9
PERMA	Average, psi	4.3	1,509,698	601,817	271,262
	Std. Dev., psi	2.1	447,548	36,673	26,349
	COV, %	49.2	29.6	6.1	9.7
CONDON	Average, psi	2.7	1,461,958	603,291	258,940
	Std. Dev., psi	1.9	61,628	51,809	29,395
	COV, %	71.5	4.2	8.6	11.4
HAMMOND	Average, psi	1.9	1,944,234	915,924	381,830
	Std. Dev., psi	0.6	389,101	172,546	78,733
	COV, %	31.6	20.0	18.8	20.6
WOLF POINT	Average, psi	2.1	1,937,411	658,007	241,098
	Std. Dev., psi	0.7	207,276	104,173	60,639
	COV, %	32.2	10.7	15.8	25.2
FORT BELKNAP	Average, psi	3.2	2,102,436	773,691	356,870
	Std. Dev., psi	1.3	534,091	70,950	59,017
	COV, %	41.5	25.4	9.2	16.5
ROUNDUP	Average, psi	2.8	2,728,205	1,173,687	546,429
	Std. Dev., psi	0.9	598,270	56,175	37,858
	COV, %	33.3	21.9	4.8	6.9
LAVINA	Average, psi	2.3	2,040,282	1,058,414	699,614
	Std. Dev., psi	0.6	324,844	64,305	219,805
	COV, %	27.8	15.9	6.1	31.4
GEYSER	Average, psi	5.2	1,619,904	488,566	231,267
	Std. Dev., psi	1.4	494,578	93,266	66,508
	COV, %	26.6	30.5	19.1	28.8

The average air voids measured on the recovered cores are relatively low, which suggests that the mixes were adequately compacted during construction:

- Five sites have air voids less than 3 percent.
- Three sites have air voids between 3 to 5 percent
- Two sites have air voids just slightly greater than 5 percent.

**Table 6.3 Summary of Laboratory Determined Tensile Strength
for Asphalt Concrete Materials**

Site	Sample	Air Voids, %			Tensile Strength, psi			Strain at Failure, in/in		
		4C	16C	27C	4C	16C	27C	4C	16C	27C
SILVERCITY	1	4.3	2.1	2.2	482	147	62	0.0044	0.0090	0.0112
	2	1.8	3.4	3.3	465	196	85	0.0035	0.0062	0.0101
	Average	3.1	2.7	2.7	474	171	74	0.0040	0.0076	0.0106
BECKHILL	1	4.5	4.6	4.7	446	204	92	0.0045	0.0074	0.0143
	2	5.7	5.3	5.0	430	191	93	0.0043	0.0078	0.0129
	Average	5.1	5.0	4.9	438	197	92	0.0044	0.0076	0.0136
PERMA	1	6.4	4.0	4.4	450	197	94	0.0038	0.0103	0.0113
	2	2.1	3.6	3.3	535	202	86	0.0036	0.0093	0.0125
	Average	4.3	3.8	3.9	493	200	90	0.0037	0.0098	0.0119
CONDON	1	4.6	3.7	2.6	410	144	84	0.0034	0.0078	0.0096
	2	0.8	0.8	1.7	424	160	84	0.0057	0.0058	0.0131
	Average	2.7	2.3	2.2	417	152	84	0.0045	0.0068	0.0114
HAMMOND	1	1.2	1.4	1.6	543	235	88	0.0034	0.0042	0.0080
	2	2.4	2.1	2.0	554	216	123	0.0025	0.0052	0.0065
	Average	1.8	1.7	1.8	548	225	106	0.0029	0.0047	0.0073
WOLF POINT	1	2.7	1.4	1.8	483	151	65	0.0026	0.0081	0.0160
	2	1.4	1.7	2.0	528	151	68	0.0042	0.0104	0.0116
	Average	2.1	1.5	1.9	506	151	67	0.0034	0.0092	0.0138
FORT BELKNAP	1	4.6	2.8	2.8	389	153	58	0.0029	0.0085	0.0127
	2	2.0	4.4	3.1	488	144	95	0.0033	0.0090	0.0104
	Average	3.3	3.6	2.9	439	149	77	0.0031	0.0088	0.0116
ROUNDUP	1	1.9	3.4	2.7	508	210	117	0.0036	0.0061	0.0057
	2	3.8	2.6	3.2	461	235	101	0.0032	0.0038	0.0190
	Average	2.8	3.0	3.0	484	223	109	0.0034	0.0050	0.0124
LAVINA	1	2.9	2.3	2.5	414	210	116	0.0043	0.0124	0.0146
	2	1.6	2.6	2.4	464	236	141	0.0046	0.0053	0.0064
	Average	2.3	2.5	2.4	439	223	128	0.0045	0.0088	0.0105
GEYSER	1	3.8	4.7	5.5	458	157	76	0.0055	0.0082	0.0128
	2	6.3	6.3	5.3	337	145	80	0.0057	0.0098	0.0132
	Average	5.1	5.5	5.4	397	151	78	0.0056	0.0090	0.0130

Most of these mixes are believed to have typical fatigue characteristics based on the HMA resilient modulus and indirect tensile strain at failure.

CTB Cores (Subcontractors – The University of Texas, Austin, TX, Fugro South, Inc. Houston, TX): The objective for testing the CTB cores was to obtain the elastic modulus of the material. Five samples from the four sites that had CTB layers were sent to the testing subcontractor and they were requested to perform ASTM 469 on four of the specimens. One extra sample was provided from each site to determine the ultimate strength before running the elastic modulus tests. As required by the elastic modulus test protocol, the 6" diameter cores were to be reduced to 4" diameter specimens. However, some of the cores fell apart during the 4" coring process. These were the cores where the cement content was relatively low and hence had low bond strength among the aggregate particles.

Due to the problems that were occurring with the elastic modulus testing at the University of Texas, the PI opted to test the remaining specimens using the elastic modulus test protocol at Fugro South in Houston. This required the slight modification of some existing equipment at the Houston lab and a change in the method of coring the low cement content specimens; but the testing should be completed in May 2003.

Backcalculation of Deflections: The first round of deflection tests have been backcalculated and summarized. In addition, the second round of deflection testing has also been backcalculated utilizing the same pavement structure information as the round 1 data. The data has been reviewed and compared to the data determined in the lab. Figures 6.5, 6.6, and 6.7 show these cursory comparisons. It should be noted that further analysis of these comparisons will be completed for the Task 7 calibration.

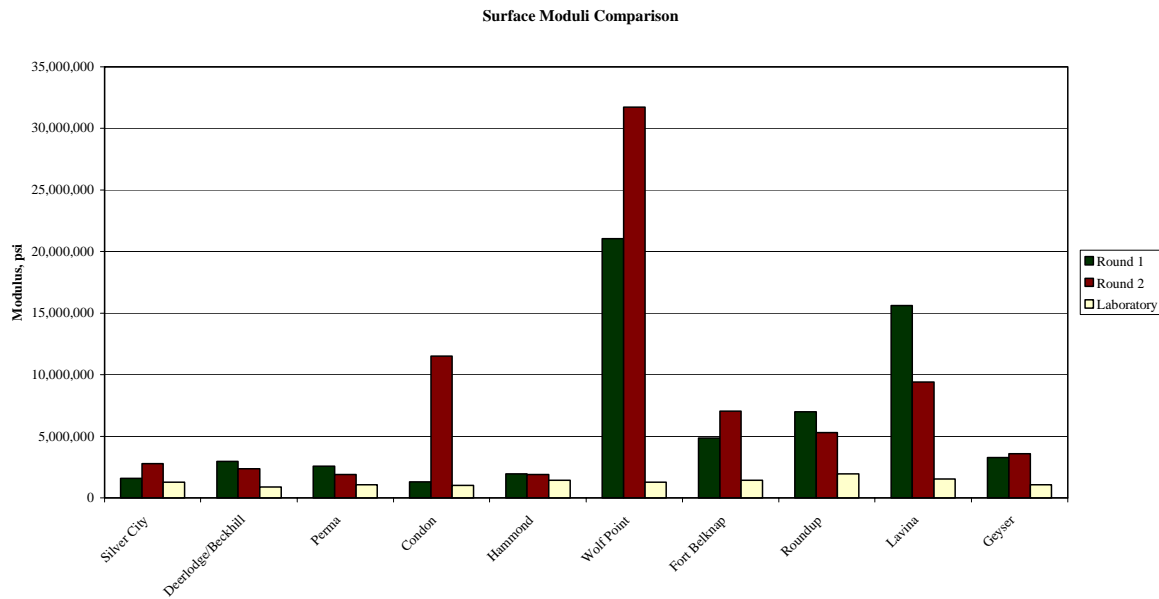


Figure 6.5 Comparison of Rounds 1 and 2 backcalculated resilient moduli and laboratory determined resilient moduli at 10C for asphalt concrete materials.

The results from Wolf Point, Condon, and Lavina need to be evaluated in closer detail because the calculated HMA modulus values are much higher than typical values.

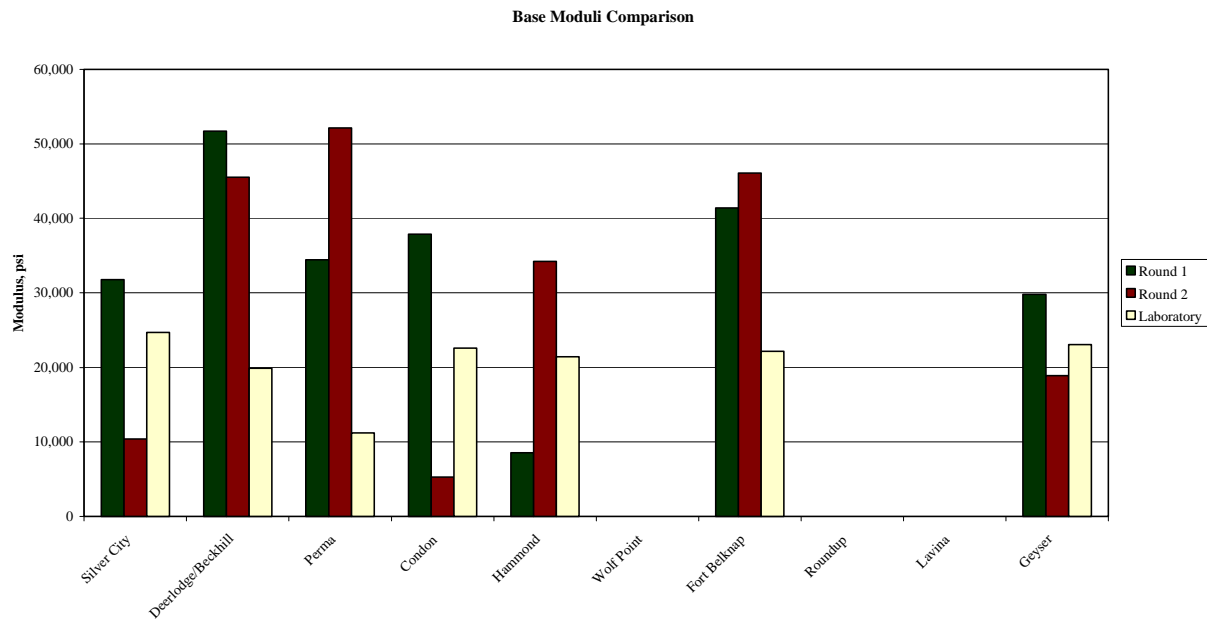


Figure 6.6 Comparison of Rounds 1 and 2 backcalculated resilient moduli and laboratory determined resilient moduli at typical stress states for unbound base materials.

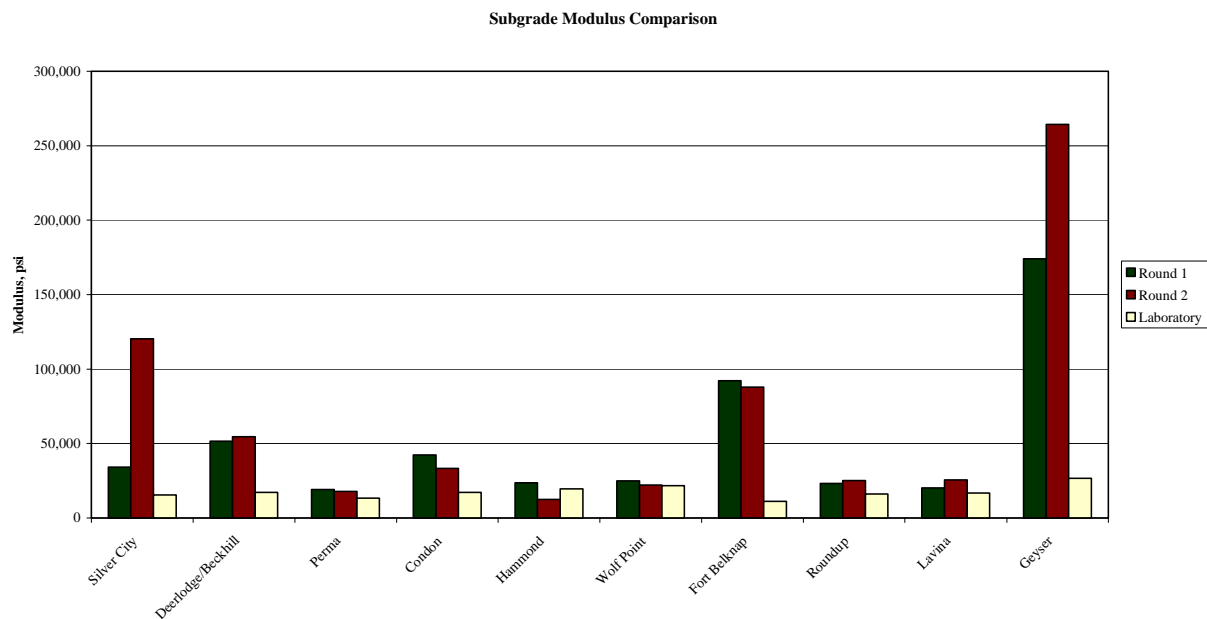


Figure 6.7 Comparison of Rounds 1 and 2 backcalculated resilient moduli and laboratory determined resilient moduli at typical stress states for subgrade materials.

Superpave Supplemental Sites: The project team has received samples from sites constructed with Superpave-designed hot mix and sampled by MDT during the time of construction. The purpose of adding these sections will be to incorporate pavements constructed with current MDT mixture design procedures. An inventory of the materials received to date is included in Table 6.4. A testing plan will be developed when the testing for the initial 10 sites has been completed.

Table 6.4 Summary of Superpave Site Materials Shipped and Stored at Fugro-BRE.

Site	Pallet	Container	Quantity	Description	Contents	Identification
Fort Belknap	1	box	6	1 qt cans	binder	NHI 7(32)429 RP 442
		box	16	1 qt cans	binder	NHI 7(32)429 RP 443
		box	2	4" cores	AC	28, 28A; NHI 7(32)429, Hwy P-1; RP 441.7
			2	4" cores	AC	29, 29A; NHI 7(32)429, Hwy P-1; RP 442.1
			2	6" cores	AC	27, 27A; NHI 7(32)429, Hwy P-1; RP 441.1
		bucket	6	5 gallon bucket	Grade S Aggregate	NHI 7(32)429, RP 441.2
		bag	6	70 lb cloth bag	PMS (bulk AC mix)	NHI 7(32)429, RP 437
Vaughn N.	2	box	4	1 qt cans	binder	IM 15-5(98)291; 454+50
			2	1 pt cans	binder	IM 15-5(98)291; 454+50
		box	6	1 qt cans	binder	IM 15-5(98)291; 454+50
		box	1	piece (9 sft)	geotextile; placed on the prepared subgrade and covered with subbase material	IM 15-5(100)291; 454+50
			8	1 pt cans	binder	IM 15-5(100)291; 454+50
			2	6" cores	AC	128, 128A IM 15-5(100)291; Hwy I-15; 454+50
			1	cloth bag	CBC both lifts; Base Course GR SA	IM 15-5(100)291; 454+50
		bucket	6	5 gallon bucket	Grade S Aggregate	IM 15-5(100)291; 454+50
		bucket	1	5 gallon bucket	Subgrade	IM 15-5(100)291; 454+50
		bucket	1	5 gallon bucket	Subbase 50/50	IM 15-5(100)291; 454+50
		3 bag	6	cloth bags	PMS (bulk AC mix)	IM 15-5(100)291; 454+50
Lothair E.	1	bucket	1	5 gallon bucket	Special Borrow (looks like subgrade material, wet sand)	NHI 5(6)308; 53+50
		bucket	1	5 gallon bucket	CBC Gr. 5A Lift 1 of 2 (looks like wet, sand+ round gravel, base material)	NHI 5(5)308; 53+50
	2	bag	1	cloth bag	CBC Lift 2 of 2 (coarse gravel no fines)	NHI 5(5)308
		bag	1	cloth bag	CTS Lift 1 of 1 (Crushed Top Surfacing; fine gravel no sand or fines)	NHI 5(5)308
		bucket	1	5 gallon bucket	Subgrade	NHI 5(5)308; 53+50
Baum Rd	3	bag	1	cloth bags	CBC 1st lift	NH8-4(22)58
		bag	1	cloth bags	CBC 2nd lift	NH8-4(22)58
		bag	1	cloth bags	CBC 3rd lift	NH8-4(22)58
		bucket	1	5 gallon bucket	Subgrade	NH8-4(22)58

Field Investigation Report: A field investigation report has been completed by the project team and includes a summary of the distress surveys, field sampling results (cores, bores and other geotechnical information), FWD Deflections (round 1 only), and longitudinal profiles from each of the supplemental sites.

Supplemental Data: Fugro-BRE contacted Dr. Vince Janoo and obtained a copy of the seasonal data and draft report entitled "Performance of Montana Highway Pavements During Spring Thaw." This data will be used in analyzing the response and performance data that were monitored and obtained from other test sections.

Task 7 – Data Analyses and Calibration of Performance Prediction Models

The objectives of this task are to demonstrate the calibration technique required to develop and maintain the various model calibration coefficients that will be used by the department both now and in the future. As discussed with the MDT, four major distress types were considered in the experimental plan and require prediction models and calibration coefficients. These include fatigue cracking (both surface initiated and bottom initiated surface cracks), thermal cracking, rutting or permanent deformation, and ride quality.

The calibration of the distress prediction models included in the 2002 Design Guide is in the process of being finalized and should be completed by June 2003. However, the calibration technique (or the specific steps required to determine calibration coefficients) can still be demonstrated to MDT utilizing models similar in nature to the AASHTO 2002 Design Guide models. The project team is moving ahead with this demonstration portion of Task 7 with data obtained from the LTPP database and the supplemental sites.

The project team has met on several occasions and is working on completing the initial calibration effort. Issues discussed at these meetings include the supplemental site testing, model selection, LTPP data gathering, database population, traffic data summarization and environmental data gathering. The following discusses these items separately.

Calibration Database Development: The initial steps required to populate the calibration and validation database have begun. The first step taken was to verify which LTPP data were missing since the last time it was checked. No significant changes in the available data were found.

Also, the status of the additional LTPP sections outside, but surrounding, Montana were verified. Each of the sections was checked for sufficient data so that only those sections with adequate data are being utilized.

In addition, Structured Query Language (SQL) statements are being developed for extracting the data required for model calibration from the LTPP IMS. These SQL statements will be provided to MDT so that future calibration efforts utilizing updated LTPP data may be streamlined.

A meeting was held with the database developer wherein specific requirements for the database were discussed. The database developer also relayed information to the PI regarding making the database user-friendly and structured in a way in which the MDT could use the database for further model calibration once this contract is complete. A database schema should be completed in May 2003. When this schema has been reviewed and checked, population of the database will commence.

Environmental Data: Montana climatic data will be utilized in the calibration effort. Specifically, the AASHTO 2002 environmental database may be used and will include information for Montana and its surrounding regions. However, it is also recommended that MDT include additional years of environmental data (up to 20 years) to better quantify the expected environmental conditions. The project team is incorporating tables into the calibration database to handle environmental data. This data will include rainfall and temperature information as well as in-situ moisture information for the appropriate environmental zones delineated in the State.

Traffic Data: A review of all the LTPP traffic tables has been initiated. The completeness of the data will be documented and the need for additional traffic information will be assessed.

Recommendations for the required traffic information have already been discussed among the project team and Mr. Von Quintus. Dr. Hallenbeck will continue gathering, reviewing and assessing this data, especially in light of the initial calibration effort currently underway.

Task 8 – Final Report and Presentation of Results

No activity.

2.0 PROBLEMS/RECOMMENDED SOLUTIONS

The project team is aware the MDT would like more updates regarding the progress of the project. The PI, in conjunction with Fugro-BRE management, is taking steps to help improve communication with MDT. A letter detailing these steps will be transmitted to MDT shortly.

It should also be noted that Dr. Weng On Tam has left Fugro-BRE. However, he has been replaced with Mr. Dragos Andrei who has recently completed his doctoral defense with Dr. Matthew Witczak at ASU. In addition, Mr. Jim Moulthrop has joined Fugro-BRE and will provide administrative oversight on the project. Mr. Moulthrop comes to Fugro-BRE with almost 40 years experience with pavements and pavement related topics. Fugro-BRE will look to Mr. Moulthrop to provide administrative oversight of the project and assist the PI in any way necessary. A letter detailing the experience of these two individuals and their role on the project will be forthcoming.

No other problems were encountered during last month and none are anticipated next month.

3.0 NEXT MONTH'S WORK PLAN

The activities planned for next month are discussed below:

- Coordinate with MDT personnel on an as-needed basis.
- Continue testing materials that are outstanding.
- Continue analysis of all data collected at the LTPP and non-LTPP test sections.
- Continue with the initial calibration demonstration effort.

4.0 FINANCIAL STATUS

Table 4.1 is a summary of the estimated expenses incurred during the reporting period.

Table 4.1 Summary of Estimated Expenses for Reporting Period

Cost Element	Cumulative Cost Through Dec 2002, \$	Current Expenditures, Jan – March 2003, \$	Cumulative Cost Through March 2003, \$
Direct Labor	40,138	7,865	48,003
Overhead	57,397	11,247	68,644
Consultants/Subcontractors	7,615		7,615
ERES/ARA	5,901	6,963	12,864
Parsons-Brinckerhoff	8,527	0	8,527
SME	523	0	523
Dr. Matthew Witczak	0	0	0
Dr. Mark Hallenbeck	3,130	0	3,130
Travel	10,802	0	10,802
Testing	22,849	18,900	41,749
Other Direct Costs	3,114	18	3,132
Fee	16,000	4,499	20,499
Total Costs	175,996	49,492	225,488

Table 4.2 provides a summary of the total expenditures by the MDT and FHWA fiscal years in comparison to the allocated funds for each year.

Table 4.2 Summary of Total Expenditures by Fiscal Year for Montana and FHWA

Montana DOT Fiscal Year			FHWA Fiscal Year		
Fiscal Year	Allocated Funds Cumulative, \$	Expenditures Cumulative, \$	Fiscal Year	Allocated Funds Cumulative, \$	Expenditures Cumulative, \$
6/1-6/30 2001	15,000	*0	6/1-9/30 2001	65,000	31,996
7/1-6/30 2002	218,969	82,420	10/1-9/30 2002	258,969	102,303
7/1-6/30 2003	348,969	143,068	10/1-9/30 2003	358,969	91,189
7/1-6/30 2004	388,969	---	10/1-9/30 2004	398,969	---
7/1-6/30 2005	428,969	---	10/1-9/30 2005	438,969	---
7/1-6/30 2006	498,969	---	10/1-9/30 2006	498,969	---
TOTAL	498,969	225,488		498,969	225,488

*June 2001 expenditures were combined with July 2001 expenditures.

Figure 4.1 is a chart illustrating the current financial status.

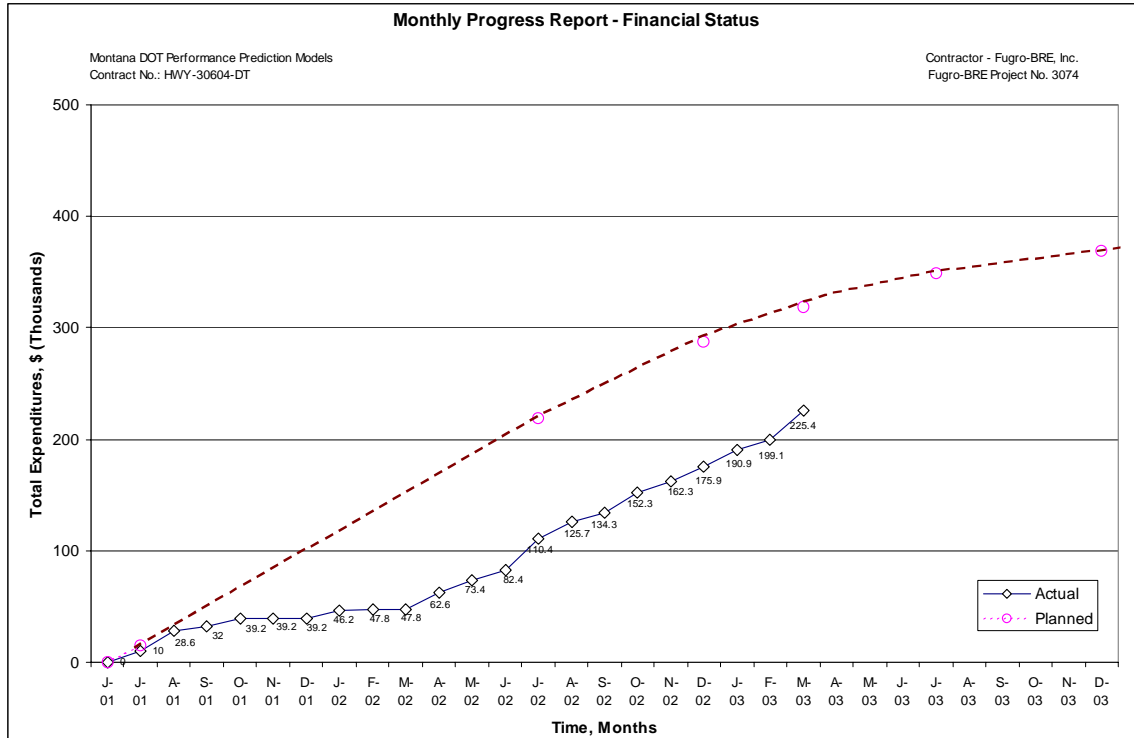


Figure 4.1 Current financial status.

cc: Jim Moulthrop, Fugro-BRE
 Dragos Andrei, Fugro-BRE
 Harold Von Quintus, ARA/ERES